

## TORREYA

Vol. 41

November-December, 1941

No. 6

**Gametophytes of *Equisetum Arvense* L.**

EDWIN B. MATZKE

(WITH FOUR FIGURES)

Gametophytes of various genera of the common ferns, Filicales, can be found without great difficulty in the field by searching in appropriate habitats—in moist shaded woodlands in proximity to mature sporophytes that discharge spores. Presumably the spores of *Equisetum*, the horsetail, often travel greater distances, and gametophytes are discovered very infrequently. The finding of large numbers of the prothallia of *E. arvense* under rather unusual circumstances, and a brief description of these gametophytes, therefore seem worthy of record.

Miss Walker (1921, 1931, 1937) has made exhaustive studies of the gametophytes of several species of *Equisetum* growing both under natural conditions and in culture. This work has thrown much light on the general nature of the gametophytes and especially on the sexual expression of the haploid generation. Miss Walker states that the finding of the gametophytes in nature "has been rare." A few specimens of *E. arvense* gametophytes were found by N. F. Petersen in 1917 at Osborn, Indiana (Walker 1921). Later Miss Walker (1931) found abundant material of this species at one other station, near Weeping Water, Nebraska, where the gametophytes occurred "on moist clay soil situated in a small bend in a creek." Miss Walker grew gametophytes of *Equisetum arvense* in culture, from spores, and studied the production of antheridia and archegonia in detail.

The same species has been studied and collected in the field in Europe in recent years by Mäckel (1924) and Schratz (1928), both of whom were interested in the sexual expression of the gametophytes. Small male prothallia were found in the field by Schratz but

TORREYA for November-December (Vol. 41:181-217) was issued December 19, 1941.

not by Mäckel. Miss Walker also obtained male plants of this species in culture. Careful examination of the prothallia of two other species of this genus has been made by Rumberg (1931), who gives an excellent review of the literature of the entire subject. Gametophytes of *E. debile* in India were investigated by Kashyap (1914, 1917), who states that a well-grown prothallium of this species may be as much as three centimeters in diameter; he figures one, natural size, of nearly two and one half centimeters. Small prothallia of this species, either male or female, were obtained under crowded conditions in culture by Kashyap.

Among the older accounts of the gametophytes of *Equisetum* may be mentioned the classical studies of Buchtien (1887), Sadebeck (1881), and Jeffrey (1899). Excellent reviews of the literature are given by Sadebeck (1900), Goebel (1930), Campbell (1930), Eames (1936), and Smith (1938).

Although it is not difficult to grow spores of *Equisetum* in culture, they have not been found under natural conditions very often. In spite of its wide distribution and common occurrence, this seems to be especially true of *E. arvense*. Eames (1936), for instance, states that gametophytes of this genus grow "on wet soil in shaded places," but that they "are rarely found in the wild." Smith (1938) states that they "are generally found growing on clayey soil and in the mud belt along the banks of streams."

At Orehill, Connecticut, a tiny hamlet between Lakeville, Connecticut, and Millerton, New York, there is a large open iron mine. According to local accounts, this mine was worked from about the year 1700 until shortly after the first World War. About 1920 the operations were discontinued, and this large pit, of numerous ramifications and varying depths, was left exposed. Water then collected within it and submerged and killed the plants that had become established at the base and part way up the slopes. Those plants that were growing on the sides of the excavation, above the level of the water of the lake thus formed, are still present.

In January, 1941, in preparation for using the iron deposits again, the emptying of the water from this pit by pumping was begun, and it was almost completed by the middle of June. This mine presented the rather unique spectacle, then, of an emptied lake, the bottom composed largely of clay and silt, and it was remarkably free of aquatic plants or their remains. The previous water level was

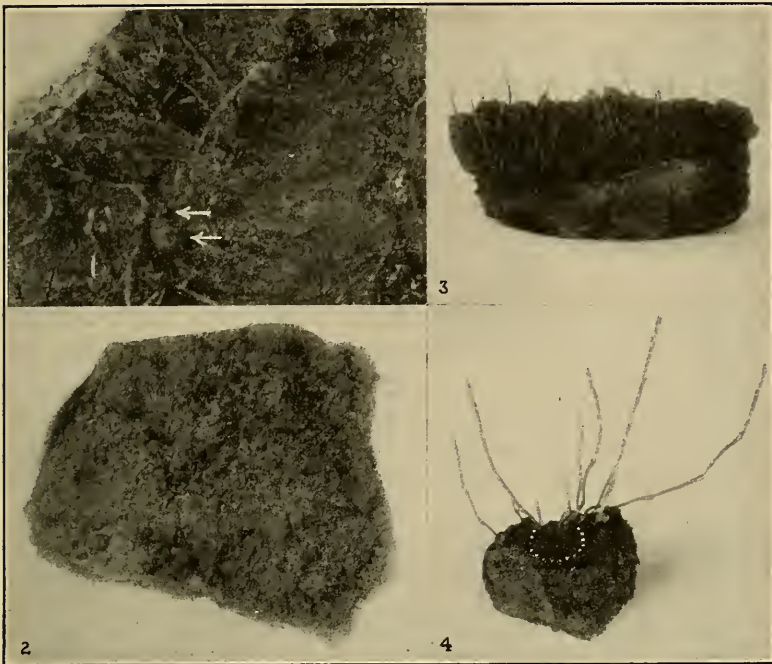


FIGURE 1. Gametophytes of *Equisetum arvense*. A large one, about 6 millimeters in diameter, is indicated with a white arrow; a smaller one beside it, dark in the photograph, is similarly indicated. Young sporophytes are also visible in the photograph. 5/6. FIGURE 2. Gametophytes of *E. arvense* of varying sizes, appearing as dark spots on the soil, some hardly visible, some several millimeters in diameter. 2/5. FIGURE 3. Young sporophytes of *E. arvense*, the gametophytes from which they originated visible at the base of some. 1/3. FIGURE 4. Gametophyte of *E. arvense*, in the white circle, bearing two sporophytes, each of which shows a primary and a secondary shoot. 5/6.

clearly and sharply delimited, and above this the steep slopes were completely occupied by plants. On the sides and bottom of the excavation, below the erstwhile water level, stood the gaunt remains of trees and shrubs that had been submerged, some presumably for two decades. At the former water level was a hydrosere, with cattails, sedges, alders, willows, etc., though the water was gone. Slightly above this former water level, mature sporophytes of *Equisetum arvense* were found growing in considerable abundance. Although strobili in this particular locality have not been studied,

this species sheds its spores in this general area in April, the last strobili discharging their contents in early May.

On June 18, 1941, Mr. Wallace Carr and the writer were studying the succession along the margins of this pit and were searching for indications of floating and submerged plants, without very much success. For the most part the recently exposed clay and silt were completely devoid of plant life. Since the removal of the water, the substratum is subject to alternate wetting and drying, and although the rain washes down over the sides and runs along the bottom of the pit, the base is not level, so that it collects in the deepest parts. The slopes are fairly steep, but the width of the pit is so great that there is little shading of the bottom, except in early morning and late afternoon. Consequently the fine soil at the base becomes alternately inundated in wet weather and more or less baked, though never completely so, in dry periods, cracking into characteristic "cakes." It was on this substratum that hundreds of gametophytes were found several hundred yards distant from mature sporophytes. Although the soil was distinctly cracked, it was not powdery and dusty, but firm enough to permit the removal of "chunks."

The gametophytes there on June 18 were very numerous and of varying sizes, some hardly visible, some about the size of a pin head, many somewhat larger, varying in diameter up to about six millimeters. They looked like hundreds of miniature green pincushions, many of them having young sporophytes that were just beginning to project visibly up into the air. Mostly they were a rather soft green in color, some were dark brownish green, while one, noticed several weeks later, was distinctly brownish red. The photographs in figures 1-4 were taken on July 8. The largest gametophyte, collected on July 19, was nearly circular in outline and measured 8 millimeters across. It bore no sporophytes, and like some of the other larger ones, had begun to break down slightly near the center. Even at that date, however, there were numerous gametophytes, without sporophytes, that were bright green and vigorous, though a larger number were disintegrating.

Some of the soil with the gametophytes was brought into the laboratory, where the prothallia were kept alive. They were more or less circular in outline, and somewhat raised in the center. One of the larger ones, about 6 mm. in diameter, is shown in figure 1;

beside it is a smaller one about 2 mm. in diameter, darker in color. Some young sporophytes are also shown in this photograph.

Upon dissection, the prothallia were seen to consist of a basal parenchymatous tissue, from the lower surface of which rhizoids developed. On the upper side of this tissue erect branches were produced, which above were variously lobed and fringed. This structure corresponds with that described by Miss Walker (1931) for the "normal thalli." She has taken up in detail the development and distribution of the archegonia and antheridia.

Miss Walker has also described male gametophytes in this species, growing under crowded conditions in culture, while Schratz (1928) found small male gametophytes, which early darkened and died, growing in the field. In the material found in Connecticut there were numerous small gametophytes, mostly brownish or black in color, which had died, though presumably not as a result of overcrowding. Whether or not these were strictly male was not established, though they seem to correspond with those described as male by Schratz. They did not bear sporophytes. They are visible as small dark spots in figure 2.

During the time that these plants were kept under observation in the field, the sporophytes developed considerably. On June 18 young sporophytes were visible, and one month later they were large and conspicuous, though some were still beginning growth at that time. Figure 3, taken on July 8, shows young sporophytes growing from the old gametophytes, some of which are visible. The gametophytes gradually died off, but on July 19 many could still be found, associated with the sporophytes or growing alone.

It was not uncommon for one gametophyte to bear more than one sporophyte. Miss Walker (1921) states that as many as eleven young sporophytes may begin development on one gametophyte in *E. laevigatum*, though not more than seven were found large enough to be visible to the naked eye. According to Kashyap (1914), *E. debile* gametophytes not uncommonly bear eight or ten sporophytes, and he figures one which he states had fifteen. In the material from Connecticut it was not uncommon to find several sporophytes originating on the same gametophyte. Figure 4 shows such a gametophyte, bearing two sporophytes, each of which is made up of a primary and a secondary shoot.

From an ecological standpoint, the gametophytes, and later the sporophytes, of *Equisetum arvense* took possession of this rather unusual habitat. A few scattered seedlings of angiospermous plants had also come in, mostly *Alisma Plantago-aquatica*, the water plantain, and some leafy moss plants and fern gametophytes had developed on this substratum. *Equisetum arvense* was by far the most common plant, however, and temporarily at least, it had actually taken possession of this bare area, having come in by means of its spores. This is a case, then, of *E. arvense* as a pioneer in a new, bare area. It is not impossible that the presence of iron in this soil may have favored the development of these gametophytes, though of course there is no evidence to support this.

#### SUMMARY

Hundreds of gametophytes of *Equisetum arvense* L. were found in the wild during June, growing in an open iron mine pit which had been pumped free of water earlier in the year.

Some of the gametophytes were fairly large, as much as eight millimeters in diameter, more or less circular in outline, and green in color. Others were much smaller, some barely visible, and they were mostly brownish or black when they were found. These latter seem to correspond with the male gametophytes of this species found in the wild in Europe by Schratz.

The gametophytes consisted essentially of a lower parenchymatous tissue from which rhizoids grew into the soil and from the upper portion of which erect branches were developed which were variously fringed and lobed.

This is a case in which *Equisetum arvense*, by means of its spores, has come into a newly exposed bare area as a pioneer and is becoming established.

COLUMBIA UNIVERSITY  
NEW YORK, N. Y.

#### Literature Cited

- Buchtien, O. 1887. Entwicklungsgeschichte des Prothallium von *Equisetum*.  
Bibliotheca Bot. 8: 1-49.  
Campbell, D. H. 1930. The structure and development of mosses and ferns.  
Third edition. New York.  
Eames, A. J. 1936. Morphology of vascular plants. Lower groups. New York.

- Goebel, K. 1930. Organographie der Pflanzen. Part 2. Third edition. Jena.
- Jeffrey, E. C. 1899. The development, structure, and affinities of the genus *Equisetum*. Mem. Boston Soc. Nat. Hist. 5: 155-190.
- Kashyap, S. R. 1914. The structure and development of the prothallus of *Equisetum debile* Roxb. Ann. Bot. 28: 163-181.
- . 1917. Notes on *Equisetum debile* Roxb. Ann. Bot. 31: 439-445.
- Mäckel, H. G. 1924. Zur Kenntnis der späteren Entwicklungsstadien der Prothallien von *Equisetum arvense*. Repert. spec. nov. Beih. 28: 1-36.
- Rumberg, J. 1931. Entwicklungsgeschichte der Prothallien von *Equisetum silvaticum* L. und *Equisetum palustre* L. Planta 15: 1-42.
- Sadebeck, R. 1881. Die Gefässkryptogamen. In Schenks Handbuch der Botanik 1: 147-326. Breslau.
- . 1900. Equisetaceae. In Engler, A. und Prantl, K. Die natürlichen Pflanzenfamilien. First ed. I, 4: 520-548.
- Schratz, E. 1928. Untersuchungen über die Geschlechterverteilung bei *Equisetum arvense*. Biol. Zentralbl. 48: 617-639.
- Smith, G. M. 1938. Cryptogamic Botany. Vol. 2. New York.
- Walker, E. R. 1921. The gametophytes of *Equisetum laevigatum*. Bot. Gaz. 71: 378-391.
- . 1931. The gametophytes of three species of *Equisetum*. Bot. Gaz. 92: 1-22.
- . 1937. The gametophyte of *Equisetum scirpoides*. Amer. Jour. Bot. 24: 40-43.

---

## Distribution in Ontario of *Dracocephalum thymiflorum*<sup>1</sup>

HERBERT GROH

A note by Prof. N. C. Fassett in TORREYA 41: 57. 1941, records the collection of *Dracocephalum thymiflorum* L. in 1938 from Manitoulin Island in the Province of Ontario, Canada, and refers to earlier stations in Massachusetts and Idaho.

Other Ontario records, unfortunately not published hitherto, should be added to that from Manitoulin. The plants sent were identified, and except the second which was returned to the Ontario Agricultural College, Guelph, Ont., have been retained in the herbarium of this division. They are from: Shelburne, Dufferin Co., John Leigh, June 4, 1931; Perth, Lanark Co., Peter Byrne, June 26, 1931; Berwick, Stormont Co., H. W. Graham, July, 1935. Mr. Graham, at the same time, had an unconfirmed report of it from near Williamsburg, Dundas Co., Ont.

---

<sup>1</sup> Contribution No. 674 from the Division of Botany and Plant Pathology, Science Service, Dominion Department of Agriculture, Ottawa, Canada.